

Agenda

1. 3GPP band classes
2. 700 MHz band support
3. Public Safety Device Requirements
4. Rural LTE Coverage

The Large Number of LTE Bands Means Vendors Have to Choose Main Global Bands for Initial Support

FDD bands

Band	Frequencies UL/DL (MHz)
1	1920 – 1980/2110 – 2170
2	1850 – 1910/1930 – 1990
3	1710 – 1785/1805 – 1880
4	1710 – 1755/2110 – 2155
5	824 – 849/869 – 894
6	830 – 840/875 – 885
7	2500 – 2570/2620 – 2690
8	880 – 915/925 – 960
9	1750 – 1785/1845 – 1880
10	1710 – 1770/2110 – 2170
11	1428 - 1453/1476 - 1501
12	698 – 716 /728 - 746
13	777 – 787 /746 - 756
14	788 – 798 /758 - 768
17	704 – 716/734 – 746

TDD bands

Band	Frequencies UL/DL (MHz)
33,34	1900 – 1920 2010 – 2025
35,36	1850 – 1910 1930 – 1990
37	1910 – 1930
38	2570 – 2620
39	1880 – 1920
40	2300 – 2400

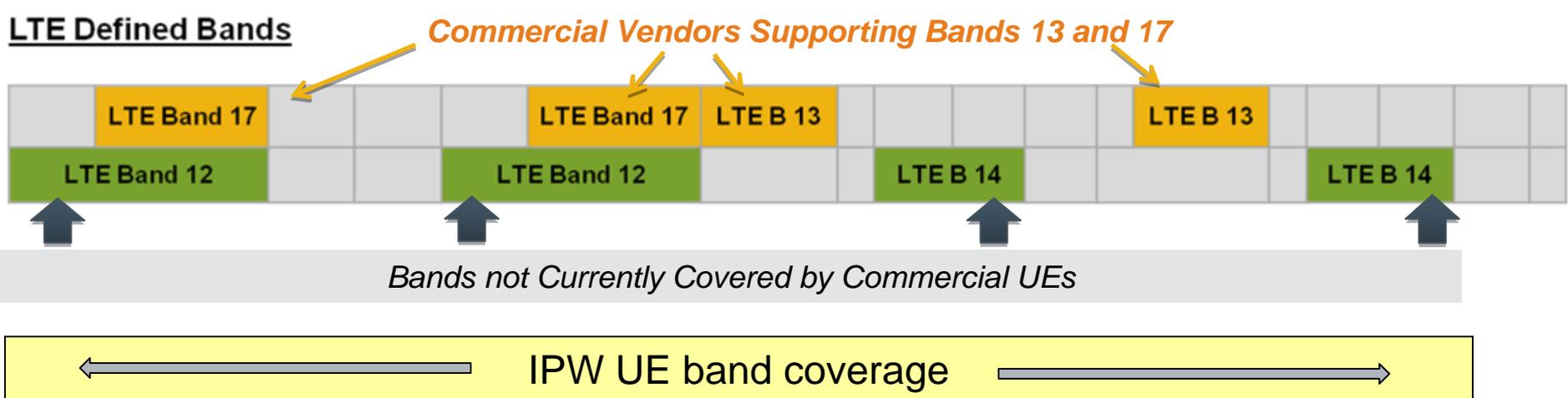
In addition, User Equipment needs to support up to 7 UMTS and GSM bands

□ UE and chipset vendors have to chose a subset of bands to support

Table 1: FDD (left) and TDD (right) frequency bands defined in the 3GPP (May 2009)

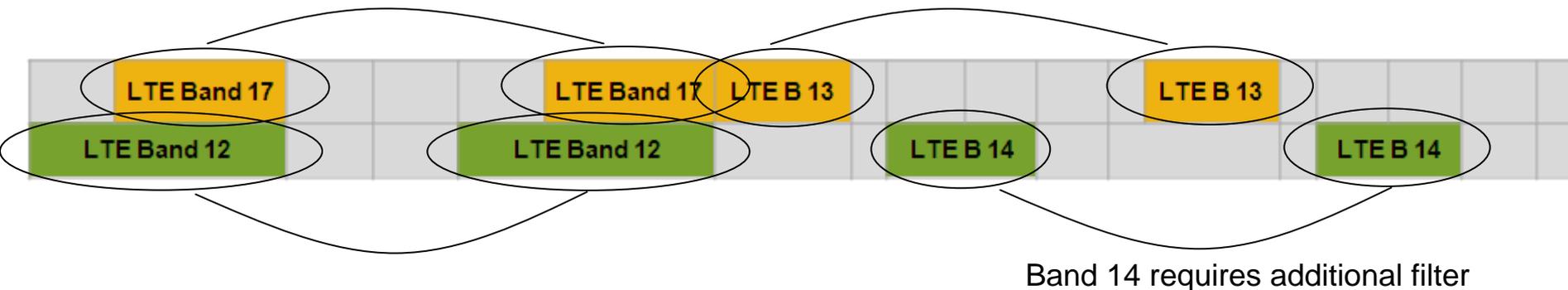
700 MHz Band Support

698	704	710	715	722	728	734	740	746	757	758	763	Public Safety	775	776	787	788	793	Public Safety	804
A	B	C	D	E	A	B	C	C	A	D			B	C	A	D			B
Regional Carriers	AT&T/regional carriers	AT&T	QCOM	QCOM/Echostar	AT&T/regional carriers	AT&T	AT&T	Verizon		TBD	Broadband PS	Narrowband PS	Verizon		TBD	Broadband PS	Narrowband PS		



Issues in Full Band Coverage

- LTE standards allow *full-duplex* FDD and *half-duplex* FDD UE's
 - Half duplex FDD UE only requires a single filter for entire band
 - Little difference in performance on a loaded network
 - IPW current UE is *half-duplex* FDD
- Full duplex FDD issues:
 - Filters:



- Band 13 and 14 could be combined in a single filter – but duplex gap may be too small
- Potential issues in lower band with interference from Mediaflo and UHF TV (below band 12)

Issues in Full Band Coverage

- Band 14 not included by commercial UE vendors
 - Not a technical issue – with full-duplex FDD UE's, they have to chose a subset of bands that is practical and economic to support
- If the D-Block becomes a commercial band, this would ensure that band 14 devices become mainstream

Public Safety Device Requirements

Public safety requires both commercial and specialized devices:

- Commercial

- PCI Express Mini Card in rugged laptops etc.
- USB sticks for legacy laptops – but not rugged



- Specialized

- Extended temperature range UE's
- Rugged / extended temp. routers for first responder vehicles
- Rugged tablet PC's, PDA's, smarthones



Commercial Smartphones for PS 700 MHz?

- iPhone, Android phones
- *Dependent on commercial operators demand for band 14 support, as these drive volume*

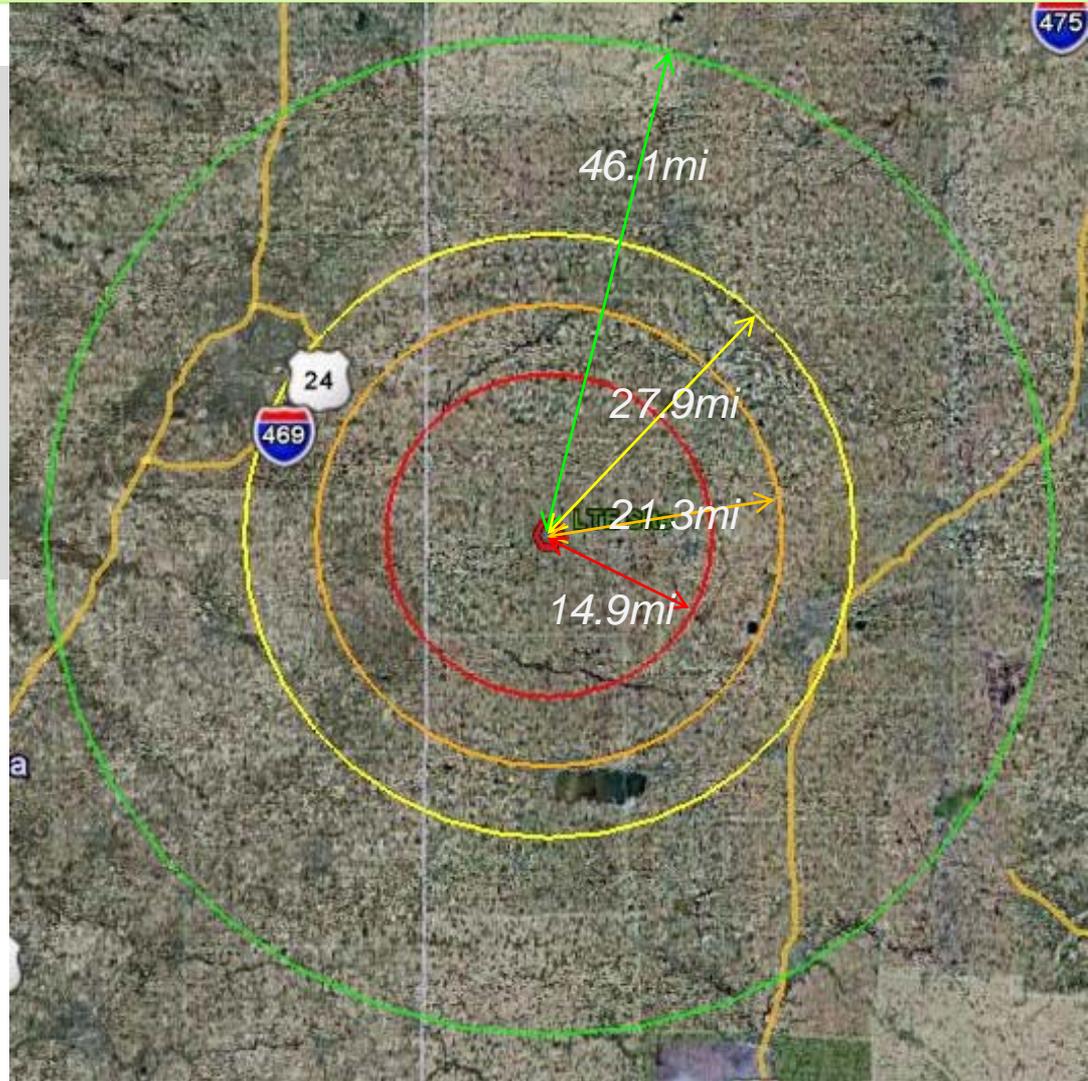
Rural Coverage with LTE

- Commercial networks in rural areas typically designed for in-car coverage – e.g. smartphone inside a vehicle
- For public safety, major coverage increase by using vehicle rooftop antenna
- Smartphone / PDA – coverage increase with “rubber ducky” antenna Vs. internal antenna

Note – with LTE, 2 antennas required for MIMO performance

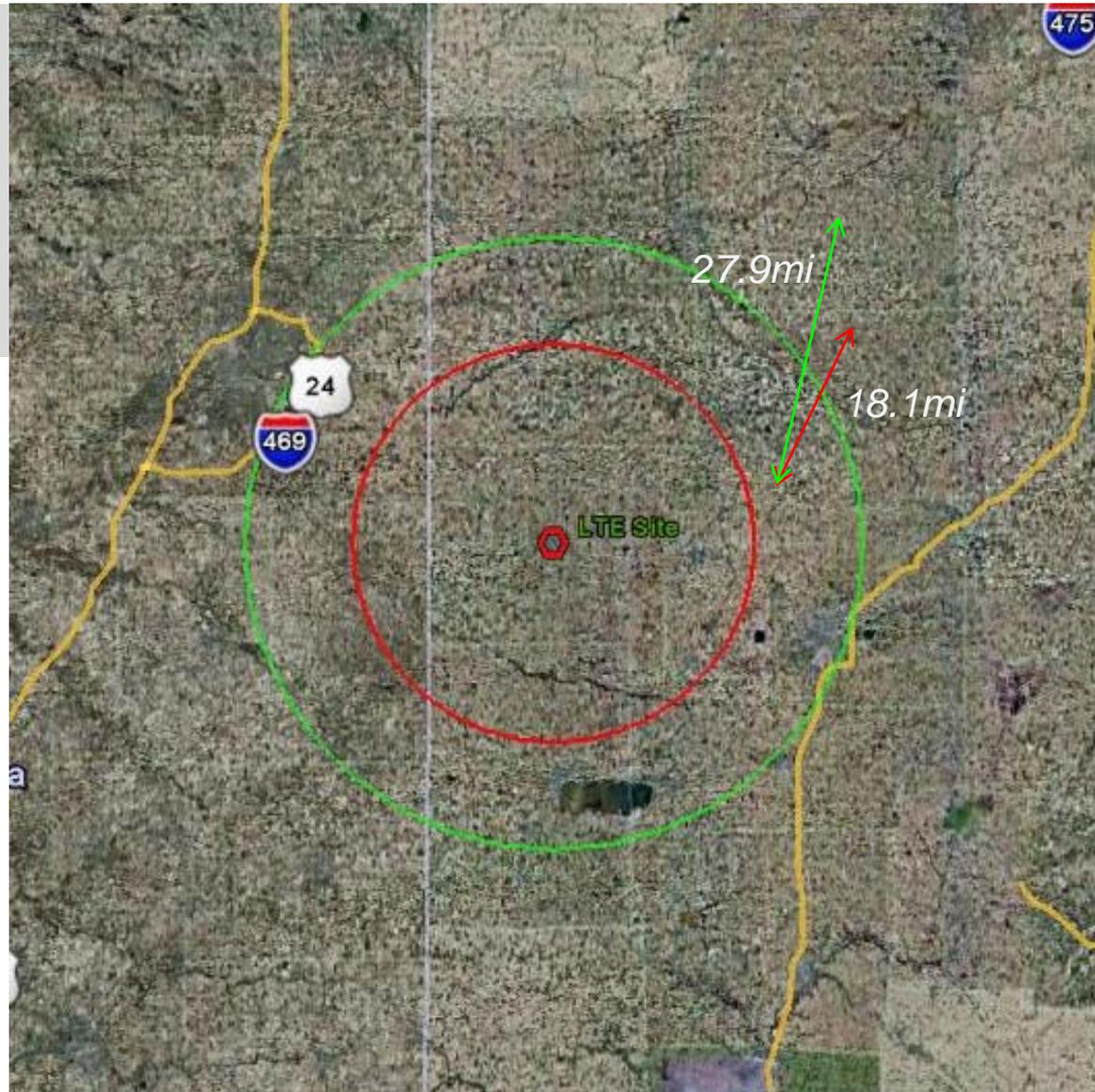
Vehicular Coverage Comparison (Rural)

- **Case 1: Smartphone In-Vehicle**
- **Case 2: Smartphone Outdoor**
- **Case 3: Vehicle Mount**
- **Case 4: Vehicle Mount High Power (30 dBm)**



Handheld Coverage Comparison (Rural)

- **Case 1:**
Smartphone
Outdoor
- **Case 2:** Rugged
PDA w/ Ext Ant.



Thank You !

Assumptions for Coverage Comparisons

- Network Assumptions:
 - eNode-B antenna Height Above Average Terrain (HAAT): 300ft
 - 200ft Elevation & 100ft Tower / 100ft Elevation & 200ft Tower / Etc.
 - LTE Link Budget – 256kbps User Uplink Rate
- User Assumptions
 - 5dB Penetration Loss for In-Vehicle Coverage
 - 3dB Body Loss Booked for Smartphone Outdoor Coverage
- Propagation Assumptions
 - COST-231 Open Area Model (rural)
 - Log-Normal Shadowing